



Answers to Concrete Field and Concrete Plant Study Questions and Problems

CHAPTER 1 – for Concrete Field and Concrete Plant

1. **Hydration** is the chemical reaction between water and cement.
2. **Workability** is the property of freshly mixed concrete which is the ease or difficulty in the placing and finishing of concrete.
3. A chemical, such as calcium chloride used to “speed up” the setting time of concrete is **accelerator**.
4. **False set** is a significant loss of plasticity shortly after the concrete is mixed.
5. The time it takes a cement paste to begin hardening is known as **setting time**.
6. A condition at which an aggregate will neither absorb moisture from concrete nor contribute moisture to the mix is **saturated surface dry**.
7. **Set retarder** is a material used for the purpose of delaying the setting time of concrete.
8. **Consistency** is a condition of plastic concrete which relates to its cohesion, wetness, or to flow.
9. **Cement** is the bonding agent used in a concrete mix.
10. The ability of hardened concrete to resist the deterioration caused by weathering, chemicals, and abrasion is known as **durability**.
11. The pH value of water used with cement shall be between **4.5** and **8.5** as found in Section **216.02**.
12. Gypsum is added to cement to control **time of set**.
13. List two desirable qualities of hardened concrete: **durability and water-tightness (others listed on page 1-1)**.
14. The primary effect of air entrainment in concrete is to improve **freeze thaw resistance**.
15. List two desirable properties of an aggregate: **low absorption and abrasive resistance (others listed on pages 1-6 to 1-8)**.

16. Admixtures shall be dispensed **according to manufacturer recommendations and within an accuracy of +/-3%.**
17. List two principal raw components in the manufacture of cement: **Lime and Silica.**
18. The type of cement which has the highest fineness reading and the highest tricalcium silicate (C3S) composition, both factors in accelerated strength is **Type III.**
19. The void content of identically graded fine aggregates will vary with **particle shape.**
20. **3.15** is the specific gravity of Portland Cement.
21. **Water-cement ratio** has the greatest effect on the strength, durability and water tightness of concrete.
22. If the amount of admixture is constant and the concrete temperature is increased, the entrained air content will **decrease.**
23. A pH value of 6.0 indicates **acidity** and a pH value of 7.5 indicates **alkalinity.**
24. The strength requirements for High Early Strength Portland Cement Concrete shall be obtained in **7 days** as stated in Section **217.08(b).**
25. In no case shall a vibrator be operated longer than **15** seconds in any one location as stated in Section **316.04(e).**
26. The specification requirements for the approval to use admixtures in Hydraulic Cement Concrete are found in Section **215.03.**
27. Each batch of concrete shall be delivered to the site of work and discharged within **90 minutes** of the time the cement is introduced into the mixture unless approved otherwise by the Engineer as found in Section **217.09(b).**
28. According to Section **217.10,** in cold weather, **water and aggregates** may be heated; however, **cement** is not to be heated.
29. Is Wash water from hydraulic cement concrete mixer operations is permitted to be reused in the concrete mix? **Yes, according to Section 216.02.**

CHAPTER 2 – Concrete PLANT

Sieve Analysis - No. 1

Check the following sieve analysis of a sample of natural sand for use in concrete subject to abrasion and determine if it meets Virginia Department of Transportation requirements for Grading "A" Sand. Circle the sieve not passing, if any.

Sieve Size	Cumulative Grams Retained	Cumulative %Retained	%Passing	VDOT Specs. (%Passing)
3/8 inch	0.0	0.0	100.0	100
No. 4	16.6	2.9	97.1	95-100
No. 8	64.5	11.3	88.7	80-100
No. 16	214.1	37.4	62.6	50-85
No. 30	389.2	67.9	32.1	25-60
No. 50	483.0	84.3	15.7	5-30
No. 100	543.4	94.8	5.2	0-10
No. 200	565.0	98.6	1.4	0-3
Total Wt.	<u>573.0</u>			

Yes XX No _____

What is the Fineness Modulus? 2.99

$$\frac{0.0+2.9+11.3+37.4+67.9+84.3+94.8}{100} = \frac{298.6}{100} = \underline{2.99}$$

Sieve Analysis - No. 2

Check the following sieve analysis of a sample of natural sand for use in concrete subject to abrasion and determine if it meets Virginia Department of Transportation requirements for Grading "A" Sand. Circle the sieve not passing, if any.

Sieve Size	Cumulative Grams Retained	Cumulative %Retained	%Passing	VDOT Specs. (%Passing)
3/8 inch	0.0	0.0	100.0	100
No. 4	6.9	1.4	98.6	95-100
No. 8	28.3	5.6	94.4	80-100
No. 16	34.9	6.9	93.1	50-85
No. 30	219.2	43.6	56.4	25-60
No. 50	398.8	79.3	20.7	5-30
No. 100	482.9	96.0	4.0	0-10
No. 200	498.1	99.0	1.0	0-3
Total Wt.	<u>503.0</u>			

Yes _____ No XX

What is the Fineness Modulus? 2.33

$$\frac{0.0+1.4+5.6+6.9+43.6+79.3+96.0}{100} = \frac{232.8}{100} = \underline{2.33}$$

Sieve Analysis - No. 3

Check the following sieve analysis of a sample of natural sand for use in concrete not subject to abrasion and determine if it meets Virginia Department of Transportation requirements for Grading "A" Sand. Circle the sieve not passing, if any.

Sieve Size	Cumulative Grams Retained	Cumulative %Retained	%Passing	VDOT Specs. (%Passing)
3/8 inch	0.0	0.0	100.0	100
No. 4	6.7	1.4	98.6	95-100
No. 8	54.0	11.3	88.7	80-100
No. 16	168.6	35.1	64.9	50-85
No. 30	340.5	70.9	29.1	25-60
No. 50	407.7	84.9	15.1	5-30
No. 100	459.1	95.6	4.4	0-10
No. 200	468.1	97.5	2.5	0-5
Total Wt.	<u>480.0</u>			

Yes XX No _____

What is the Fineness Modulus? 2.99

$$\frac{0.0+1.4+11.3+35.1+70.9+84.9+95.6}{100} = \frac{299.2}{100} = \underline{\underline{2.99}}$$

CHAPTER 3 – Concrete PLANT

ACI MIX DESIGN PROBLEM NO. 1

CLASS A4 MIX DESIGN MODIFIEDWITH Flyash

FINE AGGREGATE

COARSE AGGREGATE

F.M. 2.70DRY RODDED UNIT WT. 103 lb/ft³SP. GR. 2.64SP. GR. 2.63NOMINAL MAX. SIZE C.A. 1 inchTABLE A1.5.3.6 FACTOR 0.68OTHER DATA NEEDED FOR SPECIAL DESIGNS Flyash 20% ReplacementSp. Gr. 2.35

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.68 X 27 ft³ X UNIT WT. 103 = 1891 lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT .20 x 635 = 127 $\frac{635 - 127 = 508 \text{ lbs.}}{3.15 \times 62.4}$ = 2.58 ft³

WATER $\frac{.45 \times 635 = 286 \text{ lbs.}}{1.00 \times 62.4}$ = 4.58 ft³

AIR $\frac{6.5}{100} \% \times 27 =$ 1.76 ft³

C. AGGR. $\frac{1891 \text{ lbs.}}{\text{SP.GR. } 2.63 \times 62.4} =$ 11.52 ft³

ADDITIONAL MATERIALS $\frac{.20 \times 635 = 127}{2.35 \times 62.4} =$ 0.87 ft³

TOTAL = 21.31 ft³27.00 ft³- 21.31 ft³F.A. 5.69 ft³ X 2.64 SP.GR. X 62.4 = 937 lbs.

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 508 kgWATER 286 lbs. or 34.3 gals.AIR 6.5 %C. AGGR. 1891 lbs. - [] + []F. AGGR. 937 lbs. - [] + []ADDL. MATLS. Flyash = 127 lbs.

ACI MIX DESIGN PROBLEM NO. 2

CLASS **A4 General** MIX DESIGN

MODIFIED WITH _____

FINE AGGREGATE

COARSE AGGREGATE

F.M. 3.0DRY RODDED UNIT WT. 1051b/ft³SP. GR. 2.64SP. GR. 2.83NOMINAL MAX. SIZE C.A. 1 inchTABLE A1.5.3.6 FACTOR 0.65OTHER DATA NEEDED FOR SPECIAL DESIGNS Sp.Gr. of IP 3.02

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.65 X 27 ft³ X UNIT WT. 105 = 1843 lbs.

ABSOLUTE VOLUMES

IP

~~PORTLAND CEMENT~~

$$\frac{635}{3.15 \times 62.4} \text{ lbs.} = 3.37 \text{ ft}^3$$

WATER

$$\frac{.45 \times 635 = 286}{1.00 \times 62.4} \text{ lbs.} = 4.58 \text{ ft}^3$$

AIR

$$\frac{6.5}{100} \% \times 27 = 1.76 \text{ ft}^3$$

C. AGGR.

$$\frac{1843}{\text{SP.GR. } 2.83} \text{ lbs.} = 10.44 \text{ ft}^3$$

ADDITIONAL MATERIALS

$$\text{_____} = \text{_____ ft}^3$$

$$\text{_____} = \text{_____ ft}^3$$

$$\text{TOTAL} = 20.15 \text{ ft}^3$$

$$27.00 \text{ ft}^3$$

$$- 20.15 \text{ ft}^3$$

$$\text{F.A. } 6.85 \text{ ft}^3 \times 2.64 \text{ SP.GR.} \times 62.4 = 1128 \text{ lbs.}$$

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 635 lbs.WATER 286 lbs. or 34.3 gals.AIR 6.5 %C. AGGR. 1843 lbs. - [_____] + [_____]F. AGGR. 1128 lbs. - [_____] + [_____]

ADDL. MATLS. _____ =

_____ =

ACI MIX DESIGN PROBLEM NO. 3

CLASS **A4 Post & Rail** MIX DESIGN

MODIFIED WITH **Slag**

FINE AGGREGATE _____ COARSE AGGREGATE _____

F.M. **2.7** DRY RODDED UNIT WT. **101 lb/ft³**

SP. GR. **2.62** SP. GR. **2.62**

NOMINAL MAX. SIZE C.A. **½ inch** TABLE A1.5.3.6 FACTOR **0.56**

OTHER DATA NEEDED FOR SPECIAL DESIGNS **Slag 40% Replacement (Sp. Gr. 2.94)**

w/c 0.43

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 **0.56** X 27 ft³ X UNIT WT. **101** = **1527** lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT **.40 x 635 = 254** **635 - 254 = 381** lbs. = **1.94** ft³

3.15 x 62.4

WATER **.43 x 635 = 273** lbs. = **4.38** ft³

1.00 x 62.4

AIR **7.0** % x 27 = **1.89** ft³

100

C. AGGR. **1527** lbs. = **9.34** ft³

SP.GR. **2.62** X 62.4

ADDITIONAL MATERIALS 40% Slag **635 x .40 = 254** = **1.38** ft³

2.94 x 62.4

TOTAL = **18.93** ft³

27.00 ft³

- **18.93** ft³

F.A. **8.07** ft³ X **2.62** SP.GR. X 62.4 = **1319** lbs.

SUGGESTED QUANTITIES ± 5% TOLERANCE

CEMENT **381** lbs.

WATER **273** lbs. or **32.8** gals.

AIR **7.0** %

C. AGGR. **1527** lbs. - [] + []

F. AGGR. **1319** lbs. - [] + []

ADDL. MATLS. **Slag** = **254 lbs.**

_____ =

CLASS A4 General MIX DESIGN

FINE AGGREGATE

COARSE AGGREGATE

F.M. 3.0

DRY RODDED UNIT WT. 105 lb/ft³

SP. GR. 2.64

SP. GR. 3.04

NOMINAL MAX. SIZE C.A. 1 inch

TABLE A1.5.3.6 FACTOR 0.65

OTHER DATA NEEDED FOR SPECIAL DESIGNS Fly Ash 20% Replacement

Sp. Gr. 2.35

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.65 X 27 ft³ X UNIT WT. 105 = 1843 lbs.

$$\text{PORTLAND CEMENT } .20 \times 635 = 127 \quad \frac{635 - 127}{3.15 \times 62.4} = \frac{508}{196.56} \text{ lbs.} = 2.58 \text{ ft}^3$$
$$\text{WATER} \quad \frac{.45 \times 635}{1.00 \times 62.4} = \frac{286 \text{ lbs.}}{62.4} = 4.58 \text{ ft}^3$$
$$\text{AIR} = \frac{6.5}{100} \times 27 = 1.76 \text{ ft}^3$$
$$\text{C. AGGR.} \quad \frac{1843 \text{ lbs.}}{\text{SP.GR. } 3.04} = \frac{9.72}{\text{X } 62.4} \text{ ft}^3$$

ADDITIONAL MATERIALS	$\frac{635 \times .20 = 127}{2.35 \times 62.4}$	$= \frac{0.87}{\text{ft}^3} \text{ ft}^3$
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TOTAL = 19.51 ft³

27.00 ft³
$$- 19.51 \quad \text{ft}^3$$

F.A. 7.49 ft³ X 2.64 SP.GR. X 62.4 = 1234 lbs.

SUGGESTED QUANTITIES ± 5% TOLERANCE

CEMENT	508	lbs.
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WATER 286 lbs. or 34.3 gals.

AIR	6.5	%
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C. AGGR. 1843 lbs. - [] + []

F. AGGR. 1234 lbs. - [] + []

ADDL. MATLS. Fly Ash = 127 lbs.

$$=$$

ACI MIX DESIGN PROBLEM NO. 5CLASS A4 General MIX DESIGN

MODIFIED WITH _____

FINE AGGREGATE _____ COARSE AGGREGATE _____

F.M. 2.8 DRY RODDED UNIT WT. 100 lb/ft³

SP. GR. 2.64 SP. GR. 3.04

NOMINAL MAX. SIZE C.A. 1 inch TABLE A1.5.3.6 FACTOR 0.67

OTHER DATA NEEDED FOR SPECIAL DESIGNS IS Sp. Gr. 3.05

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.67 X 27 ft³ X UNIT WT. 100 = 1809 lbs.**ABSOLUTE VOLUMES**

IS ~~PORTLAND~~ CEMENT $\frac{635}{3.05 \times 62.4}$ lbs. = 3.34 ft³

WATER $\frac{.45 \times 635}{1.00 \times 62.4} = 286$ lbs. = 4.58 ft³

AIR $\frac{6.5}{100} \% \times 27 = 1.76$ ft³

C. AGGR. $\frac{1809}{\text{SP.GR. } 3.04} \times 62.4 = 9.54$ ft³

ADDITIONAL MATERIALS _____ = _____ ft³

_____ = _____ ft³

TOTAL = 19.22 ft³

27.00 ft³

- 19.22 ft³

F.A. 7.78 ft³ X 2.64 SP.GR. X 62.4 = 1282 lbs.

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 635 lbs.WATER 286 lbs. or 34.3 gals.AIR 6.5 %C. AGGR. 1809 lbs. - [] + []F. AGGR. 1282 lbs. - [] + []ADDL. MATLS. _____ =
_____ =

ACI MIX DESIGN PROBLEM NO. 6

CLASS A3 General MIX DESIGN

MODIFIED WITH Slag

FINE AGGREGATE

COARSE AGGREGATE

F.M. 3.0DRY RODDED UNIT WT. 99 lb/ft³SP. GR. 2.64SP. GR. 2.62NOMINAL MAX. SIZE C.A. 1 inchTABLE A1.5.3.6 FACTOR 0.65OTHER DATA NEEDED FOR SPECIAL DESIGNS 40% Slag Replacement (Sp. Gr. 2.94)

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.65 X 27 ft³ X UNIT WT. 99 = 1737 lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT .40 x 588 = 235 $\frac{588 - 235 = 353}{3.15 \times 62.4}$ lbs. = 1.80 ft³

WATER $\frac{.49 \times 588 = 288}{1.00 \times 62.4}$ lbs. = 4.62 ft³

AIR $\frac{6.0}{100} \% \times 27 =$ 1.62 ft³

C. AGGR. $\frac{1737}{\text{SP.GR. } 2.62 \times 62.4}$ lbs. = 10.62 ft³

ADDITIONAL MATERIALS $\frac{.40 \times 588 = 235 \text{ lbs.}}{2.94 \times 62.4} =$ 1.28 ft³

= ft³

TOTAL = 19.94 ft³

27.00 ft³- 19.94 ft³F.A. 7.06 ft³ X 2.64 SP.GR. X 62.4 = 1163 lbs.

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 353 lbs.WATER 288 lbs. or 34.6 gals.AIR 6.0 %C. AGGR. 1737 lbs. - [] + []F. AGGR. 1163 lbs. - [] + []ADDL. MATLS. Slag = 235 lbs.

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ACI MIX DESIGN PROBLEM NO. 7CLASS A3 Paving MIX DESIGN

FINE AGGREGATE MODIFIED WITH Slag COARSE AGGREGATE
 F.M. 2.7 DRY RODDED UNIT WT. 104 lb/ft³
 SP. GR. 2.64 SP. GR. 2.60
 NOMINAL MAX. SIZE C.A. 1 inch TABLE A1.5.3.6 FACTOR 0.68
 OTHER DATA NEEDED FOR SPECIAL DESIGNS 50% Slag Replacement (Sp. Gr. 2.94)
 QUANTITY OF COARSE AGGREGATE
 TABLE A1.5.3.6 0.68 X 27 ft³ X UNIT WT. 104 = 1909 lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT $.50 \times 564 = 282$ $\frac{564 - 282}{3.15 \times 62.4} = \frac{282}{199.8} = 1.43$ ft³
 WATER $.49 \times 564 = 276$ $\frac{276}{1.00 \times 62.4} = 4.42$ ft³
 AIR $\frac{6.0}{100} \% \times 27 = 1.62$ ft³
 C. AGGR. $\frac{1909}{\text{SP.GR. } 2.60} \text{ lbs.} = 11.77$ ft³
 ADDITIONAL MATERIALS 50% Slag $\frac{564 \times .50}{2.94 \times 62.4} = 1.54$ ft³
 TOTAL = 20.78 ft³
 27.00 ft³
 - 20.78 ft³
 F.A. 6.22 ft³ X 2.64 SP.GR. X 62.4 = 1025 lbs.

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 282 lbs.
 WATER 276 lbs. or 33.1 gals.
 AIR 6.0 %
 C. AGGR. 1909 lbs. - [] + []
 F. AGGR. 1025 lbs. - [] + []
 ADDL. MATLS. Slag = 282 lbs.
 _____ =

ACI MIX DESIGN PROBLEM NO. 8 - MODIFIED WITH FLY ASH

CLASS A3 General MIX DESIGN

MODIFIED WITH Fly Ash
COARSE AGGREGATE

FINE AGGREGATE

F.M. 2.8

DRY RODDED UNIT WT. 105 lb/ft³

SP. GR. 2.64

SP. GR. 2.63

NOMINAL MAX. SIZE C.A. 1 inch

TABLE A1.5.3.6 FACTOR 0.67

OTHER DATA NEEDED FOR SPECIAL DESIGNS 20% Fly Ash Replacement
Sp. Gr. 2.22

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.67 X 27 ft³ X UNIT WT. 105 = 1899 lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT $\frac{588 \times .80 = 470 \text{ lbs.}}{3.15 \times 62.4} = \underline{2.39} \text{ ft}^3$

WATER $\frac{.49 \times 588 = 288 \text{ lbs.}}{1.00 \times 62.4} = \underline{4.62} \text{ ft}^3$

AIR $\frac{6.0}{100} \% \times 27 = \underline{1.62} \text{ ft}^3$

C. AGGR. $\frac{1899 \text{ lbs.}}{\text{SP.GR. } 2.63 \times 62.4} = \underline{11.57} \text{ ft}^3$

ADDITIONAL MATERIALS $\frac{588 \times .20 = 118}{2.22 \times 62.4} = \underline{0.85} \text{ ft}^3$

TOTAL = 21.05 ft³

27.00 ft³

- 21.05 ft³

F.A. 5.95 ft³ X 2.64 SP.GR. X 62.4 = 980 lbs.

SUGGESTED QUANTITIES ± 5% TOLERANCE

CEMENT 470 lbs.

WATER 288 kg or 34.6 gals.

AIR 6.0 %

C. AGGR. 1899 lbs. - [] + []

F. AGGR. 980 lbs. - [] + []

ADDL. MATLS. Fly Ash = 118 lbs.

_____ =

ACI MIX DESIGN PROBLEM NO. 9 - MODIFIED WITH FLY ASHCLASS A4 General MIX DESIGNMODIFIED WITH Fly Ash
COARSE AGGREGATE

FINE AGGREGATE

F.M. 3.0DRY RODDED UNIT WT. 98 lb/ft³SP. GR. 2.64SP. GR. 2.62NOMINAL MAX. SIZE C.A. 1 inchTABLE A1.5.3.6 FACTOR 0.65OTHER DATA NEEDED FOR SPECIAL DESIGNS 25% Fly Ash Replacement
Sp. Gr. 2.30

QUANTITY OF COARSE AGGREGATE

TABLE A1.5.3.6 0.65 X 27 ft³ X UNIT WT. 98 = 1720 lbs.**ABSOLUTE VOLUMES**PORTLAND CEMENT .25 x 635 = 159 $\frac{635 - 159}{3.15 \times 62.4} = 2.42$ lbs. = 2.42 ft³WATER .45 x 635 = 286 lbs. = 4.58 ft³
1.00 x 62.4AIR 6.5 % x 27 = 1.76 ft³
100C. AGGR. $\frac{1720}{2.62 \times 62.4} = 10.52$ lbs. = 10.52 ft³ADDITIONAL MATERIALS $\frac{635 \times .25 = 159}{2.30 \times 62.4} = 1.11$ ft³
= 1.11 ft³TOTAL = 20.39 ft³27.00 ft³- 20.39 ft³F.A. 6.61 ft³ X 2.64 SP.GR. X 62.4 = 1089 lbs.

SUGGESTED QUANTITIES

± 5% TOLERANCE

CEMENT 476 lbs.WATER 286 lbs. or 34.3 gals.AIR 6.5 %C. AGGR. 1720 lbs. - [] + []F. AGGR. 1089 lbs. - [] + []ADDL. MATLS. Fly Ash = 159 lbs.

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ACI MIX DESIGN PROBLEM NO. 10 - MODIFIED WITH SLAG

CLASS A4 Post & Rail MIX DESIGN

MODIFIED WITH Slag

FINE AGGREGATE	COARSE AGGREGATE
F.M. <u>2.80</u>	DRY RODDED UNIT WT. <u>102 lb/ft³</u>
SP. GR. <u>2.83</u>	SP. GR. <u>2.81</u>
NOMINAL MAX. SIZE C.A. <u>½ inch</u>	TABLE A1.5.3.6 FACTOR <u>0.55</u>
OTHER DATA NEEDED FOR SPECIAL DESIGNS <u>Slag 50% Replacement (Sp. Gr. 2.85)</u>	

QUANTITY OF COARSE AGGREGATE
TABLE A1.5.3.6 0.55 X 27 ft³ X UNIT WT. 102 = 1515 lbs.

ABSOLUTE VOLUMES

PORTLAND CEMENT 635 x .50 = 318 $\frac{635 - 318}{3.15 \times 62.4} = \frac{317}{197.76} = 1.61$ ft³

WATER $\frac{.45 \times 635}{1.00 \times 62.4} = \frac{286}{62.4} = 4.58$ ft³

AIR $\frac{7.0}{100} \times 27 = 1.89$ ft³

C. AGGR. $\frac{1515}{\text{SP.GR. } 2.81} \times 62.4 = 8.64$ ft³

ADDITIONAL MATERIALS 50% Slag $\frac{635 \times .50}{2.85 \times 62.4} = \frac{318}{178.74} = 1.79$ ft³

TOTAL = 18.51 ft³

27.00 ft³

- 18.51 ft³

F.A. 8.49 ft³ X 2.83 P.GR. X 62.4 = 1499 lbs.

SUGGESTED QUANTITIES ± 5% TOLERANCE

CEMENT 317 lbs.

WATER 286 lbs. or 34.3 gals.

AIR 7.0 %

C. AGGR. 1515 lbs. - [] + []

F. AGGR. 1499 lbs. - [] + []

ADDL. MATLS. Slag 50% = 318 lbs.

_____ =

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 1

The following Class A4 General Use mix design produced a harsh mix. The contractor wants to reduce the harshness. What are the maximum allowable adjustments under VDOT specifications that could be made to reduce the harshness?

Mix Design - One Cu. Yard
Based on SSD Condition

IP Cement	635 lbs.	Sand - F. M.	2.80
Sand	1150 lbs.	Sand - Sp. Gr.	2.64
No. 57	1954 lbs.	CA - Sp. Gr.	3.04
Water	286 lbs.	CA - Unit Weight	108 lb/ft ³
Air	6.5 %	IP Cement - Sp. Gr.	3.05

ANSWERS

Cement 635 lbs.

Sand 1208 lbs.

No. 57 1888 lbs.

Water 286 lbs.

Air 6.5% lbs.

CALCULATIONS:

SAND: $1150 \times 0.05 = 57.5$

$1150 + 58 = 1208$

NO 57: $\frac{58}{2.64 \times 62.4} = \frac{58}{164.736} = 0.35$

$0.35 \times 3.04 \times 62.4 = 66.0$

$1954 - 66 = 1888$

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 2

The following Class A3 General Use mix design produced a harsh mix. The contractor wants to reduce the harshness. What are the maximum allowable adjustments under VDOT specifications that could be made to reduce the harshness?

Mix Design - One Cu. Yard
Based on SSD Condition

IS Cement	588 lbs.	Sand - F. M.	2.70
Sand	983 lbs.	Sand - Sp. Gr.	2.66
No. 57	1909 lbs.	CA - Sp. Gr.	2.61
Water	288 lbs.	CA - Unit Weight	104 lb/ft ³
Air	6.0 %	IS Cement - Sp. Gr.	3.02

ANSWERS

Cement 588 lbs.

Sand 1032 lbs.

No. 57 1860 lbs.

Water 288 lbs.

Air 6.0 %

CALCULATIONS:

SAND: $983 \times 0.05 = 49.15$

$983 + 49 = 1032$

NO 57: $\frac{49}{2.66 \times 62.4} = \frac{49}{165.984} = 0.30$

$0.30 \times 2.61 \times 62.4 = 49$

$1909 - 49 = 1860$

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 3

The following Class A4 General Use mix design modified with 40% slag produced a harsh mix. The contractor wants to reduce the harshness. What are the maximum allowable adjustments under VDOT specifications that could be made to reduce the harshness?

Mix Design - One Cu. Yard
Based on SSD Condition

Cement	381 lbs.	Sand - F. M.	2.70
Sand	1285 lbs.	Sand - Sp. Gr.	2.62
No. 57	1799 lbs.	CA - Sp. Gr.	3.04
Water	286 lbs.	CA - Unit Weight	98 lb/ft ³
Air	6.5 %		
Slag	254 lbs.	Slag - Sp. Gr.	2.95

ANSWERS

Cement 381 lbs.

Sand 1349 lbs.

No. 57 1725 lbs.

Water 286 lbs.

Air 6.5 %

Slag 254 lbs.

CALCULATIONS:

SAND: $1285 \times 0.05 = 64.25$

$1285 + 64 = 1349$

NO 57: $\frac{64}{2.62 \times 62.4} = \frac{64}{163.488} = 0.39$

$0.39 \times 3.04 \times 62.4 = 74$

$1799 - 74 = 1725$

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 4

The following Class A3 General Use Mix Design produced a 2 inch slump. The contractor wants a 3 inch slump. What are the maximum allowable adjustments under VDOT specifications that could be made to increase the slump as much as possible?

Mix Design - One Cu. Yard
Based on SSD Condition

IP Cement	588 lbs.	Sand - F. M.	2.80
Sand	1107 lbs.	Sand - Sp. Gr.	2.64
No. 57	1934 lbs.	CA - Sp. Gr.	2.83
Water	288 lbs.	CA - Unit Weight	106.9 lb/ft ³
Air	6.0 %	IP Cement - Sp. Gr.	3.05

ANSWERS

Cement 588 lbs.

Sand 1052 lbs.

No. 57 1992 lbs.

Water 288 lbs.

Air 6.0 %

CALCULATIONS:

$$\text{SAND: } 1107 \times 0.05 = 55.35$$

$$1107 - 55 = 1052$$

$$\text{NO 57: } \frac{55}{2.64 \times 62.4} = 0.33$$

$$0.33 \times 2.83 \times 62.4 = 58$$

$$1934 + 58 = 1992$$

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 5

The following Class A3 general use mix design modified with 20% flyash produced a 3 inch slump. The contractor wants a 4 inch slump. What are the maximum allowable adjustments under VDOT specifications that could be made to increase the slump as much as possible?

Mix Design - One Cu. Yard
Based on SSD Condition

Cement	470 lbs.	Sand - F. M.	2.80
Sand	1120 lbs.	Sand - Sp. Gr.	2.83
No. 57	1863 lbs.	CA - Sp. Gr.	2.62
Water	288 lbs.	CA - Unit Weight	103 lb/ft ³
Air	6.0 %		
Flyash	118 lbs.	Flyash - Sp. Gr.	3.00

ANSWERS

Cement 470 lbs.
 Sand 1064 lbs.
 No. 57 1915 lbs.
 Water 288 lbs.
 Air 6.0 %
 Flyash 118 lbs.

CALCULATIONS:

SAND: $1120 \times 0.05 = 56$

$1120 - 56 = 1064$

NO 57: $\frac{56}{2.83 \times 62.4} = \frac{56}{176.592} = 0.32$

$0.32 \times 2.62 \times 62.4 = 52$

$1863 + 52 = 1915$

ACI MIX DESIGN ADJUSTMENT PROBLEM NO. 6

The following Class A4 general use mix design produced a 2 inch slump. The contractor wants a 3 inch slump. What are the maximum allowable adjustments under VDOT specifications that could be made to increase the slump as much as possible?

Mix Design - One Cu. Yard
Based on SSD Condition

IS Cement	635 lbs.	Sand - F. M.	2.90
Sand	1094 lbs.	Sand - Sp. Gr.	2.62
No. 57	1871 lbs.	CA - Sp. Gr.	2.83
Water	286 lbs.	CA - Unit Weight	105 lb/ft ³
Air	6.5 %	IS Cement - Sp. Gr.	3.02

ANSWERS

Cement 635 lbs.

Sand 1039 lbs.

No. 57 1931 lbs.

Water 286 lbs.

Air 6.5 %

CALCULATIONS:

SAND: $1094 \times 0.05 = 54.7$

$1094 - 55 = 1039$

NO 57: $\frac{55}{2.62 \times 62.4} = \frac{55}{163.488} = 0.34$

$0.34 \times 2.83 \times 62.4 = 60$

$1871 + 60 = 1931$

CHAPTER 9 – Concrete PLANT

MOISTURE PROBLEM NO. 1

- A. Given the following information, determine the percent of free moisture in the sand and No. 57.

SAND

Weight of wet sample = 635 grams

Weight of dry sample = 598 grams

NO. 57

Weight of wet sample = 1240 grams

Weight of dry sample = 1220 grams

ABSORPTION

Sand = 0.6%

No. 57 = 0.2%

Free Moisture: Sand 5.6% No. 57 1.4%

CALCULATIONS:

Sand:	$\begin{array}{r} 635 \\ -598 \\ \hline 37 \end{array}$	$\frac{37}{598} \times 100 = 6.2$	$\begin{array}{r} 6.2 \\ -0.6 \\ \hline 5.6\% \end{array}$
No. 57	$\begin{array}{r} 1240 \\ -1220 \\ \hline 20 \end{array}$	$\frac{20}{1220} \times 100 = 1.6$	$\begin{array}{r} 1.6 \\ -0.2 \\ \hline 1.4\% \end{array}$

- B. Based on the preceding moisture determination, correct the following mix design weights to batch weights or “pull weights” for one cubic yard.

Mix Design - One Cubic Yard
Based on SSD Condition

Batch Quantities

Cement	635 lbs.	Cement	<u>635</u> lbs.
Sand	1067 lbs.	Sand	<u>1127</u> lbs.
No. 57	1835 lbs.	No. 57	<u>1861</u> lbs.
Water	288 lbs.	Water	<u>202</u> lbs.
			<u>24.2</u> gals.
Air	6.5 %	Air	<u>6.5</u> %

CALCULATIONS:

$$\begin{aligned}
 \text{Sand:} \quad & 1067 \times 0.056 = 60 \\
 & 1067 + 60 = 1127 \\
 \text{No. 57:} \quad & 1835 \times 0.014 = 26 \\
 & 1835 + 26 = 1861 \\
 \text{Water:} \quad & 60 + 26 = 86 \\
 & 288 - 86 = 202 \\
 & \frac{202}{8.33} = 24.2 \text{ gals.}
 \end{aligned}$$

MOISTURE PROBLEM NO. 2

- A. Given the following information, determine the percent of free moisture in the sand and No. 57.

SAND

Weight of wet sample = 628 grams

Weight of dry sample = 582 grams

NO. 57

Weight of wet sample = 1245 grams

Weight of dry sample = 1215 grams

ABSORPTION

Sand = 0.9%

No. 57 = 0.4%

Free Moisture: Sand 7.0% No. 57 2.1%

CALCULATIONS:

Sand:	$\begin{array}{r} 628 \\ -582 \\ \hline 46 \end{array}$	$\begin{array}{r} 46 \\ 582 \times 100 = 7.9 \end{array}$	$\begin{array}{r} 7.9 \\ -0.9 \\ \hline 7.0 \end{array}$
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No. 57:	$\begin{array}{r} 1245 \\ -1215 \\ \hline 30 \end{array}$	$\begin{array}{r} 30 \\ 1215 \times 100 = 2.5 \end{array}$	$\begin{array}{r} 2.5 \\ -0.4 \\ \hline 2.1 \end{array}$
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- B. Based on the preceding moisture determination, correct the following mix design weights to batch weights or “pull weights” for one cubic yard.

Mix Design - One Cubic Yard
Based on SSD Condition

Batch Quantities

Cement	635 lbs.	Cement	<u>635</u> lbs.
Sand	1070 lbs.	Sand	<u>1145</u> lbs.
No. 57	1840 lbs.	No. 57	<u>1879</u> lbs.
Water	286 lbs.	Water	<u>172</u> lbs.
			<u>20.6</u> gals.
Air	6.0 %	Air	<u>6.0</u> %

CALCULATIONS:

$$\begin{aligned}
 \text{Sand:} \quad & 1070 \times 0.070 = 75 \\
 & 1070 + 75 = 1145 \\
 \text{No. 57:} \quad & 1840 \times 0.021 = 39 \\
 & 1840 + 39 = 1879 \\
 \text{Water:} \quad & 75 + 39 = 114 \\
 & 286 - 114 = 172 \\
 & \frac{172}{8.33} = 20.6 \text{ gals.}
 \end{aligned}$$

MOISTURE PROBLEM NO. 3

- A. Given the following information, determine the percent of free moisture in the sand and No. 57.

SAND

Weight of wet sample = 621 grams
 Weight of dry sample = 580 grams

NO.57

Weight of wet sample = 1362 grams
 Weight of dry sample = 1343 grams

ABSORPTION

Sand = 0.7%
 No. 57 = 0.4%

Free Moisture: Sand 6.4% No. 57 1.0%

CALCULATIONS:

Sand:	$\begin{array}{r} 621 \\ -580 \\ \hline 41 \end{array}$	$\frac{41}{580} \times 100 = 7.1$	$\begin{array}{r} 7.1 \\ -0.7 \\ \hline 6.4 \end{array}$
No. 57	$\begin{array}{r} 1362 \\ -1343 \\ \hline 19 \end{array}$	$\frac{19}{1343} \times 100 = 1.4$	$\begin{array}{r} 1.4 \\ -0.4 \\ \hline 1.0 \end{array}$

- B. Based on the preceding moisture determination, correct the following mix design weights to batch weights or “pull weights” for four cubic yards.

Mix Design - One Cubic Yard
Based on SSD Condition

Batch Quantities

Cement	635 lbs.	Cement	<u>2540</u> lbs.
Sand	1070 lbs.	Sand	<u>4552</u> lbs.
No. 57	1840 lbs.	No. 57	<u>7432</u> lbs.
Water	286 lbs.	Water	<u>800</u> lbs.
			<u>96.0</u> gals.
Air	7.0 %	Air	<u>7.0</u> %

CALCULATIONS:

Sand:	$1070 \times 0.064 = 68$
	$(1070 + 68) \times 4 = 4552$
No. 57:	$1840 \times 0.010 = 18$ (1840
	$+ 18) \times 4 = 7432$
Water:	$68 + 18 = 86$
	$(286 - 86) \times 4 = 800$
	$\frac{800}{8.33} = 96.0$ gals.
Cement:	$635 \times 4 = 2540$

CHAPTER 5 – Concrete PLANT

1. Before any concrete is batched, the producer's technician should determine that there is an approved **mixdesign** at the plant.
2. The required weighing accuracy for cement is **1 percent**.
3. Aggregates arriving at a plant by truck are acceptable for use if they are accompanied by a **statement of certification**.
4. Hopper and cement scales for batching concrete materials must be **serviced by a Private Scale Company**.
5. Aggregates should be handled and stockpiled in such a manner as to minimize **segregation**.
6. The required weighing accuracy for aggregate is **2 percent**.
7. The minimum and maximum limits of volume of concrete which can be mixed in a mixer are **15 percent-110 percent**.
8. The loader should remain **12 inches** from the ground while removing material if stockpiles are built on the ground.

CHAPTER 6 – Concrete PLANT

1. **Producer's Technician** is responsible for designing the Concrete Mix.
2. **Producer's Technician** is responsible for assuring that concrete components are certified or approved.
3. **District Concrete Technician** is responsible for conducting the performance tests, such as yield tests.
4. Making the moisture correction for aggregate is the responsibility of the **Producer's Technician**.
5. Setting all the dials, gauges, scales, and meters at the batch plant is the responsibility of the **Producer's Technician**.

CHAPTER 2 – Concrete FIELD

1. What is the first step in a deck repair?

Defining the repair problem

2. What are typical causes of deterioration of concrete?

Corrosion of Reinforcement

Freezing and Thawing Damage

Alkali-Silica Reaction

3. What causes corrosion of reinforcement?

Chlorides

Water

Thin Concrete Cover

4. Why is corrosion of reinforcement a problem?

Causes cracks and delaminations

5. Why is poor drainage a problem?

Water and salt ponds on the surface

Accelerates deterioration of concrete

Promotes frost damage

6. What causes freeze thaw deterioration?

Low air content in concrete

Water expands 9.1% when it freezes

7. Why is alkali silica reaction a problem?

Alkali cement reacts with silica aggregates forming a gel around aggregates

Gel absorbs water and swells

Expanding gel cracks concrete

8. How do you locate deteriorated concrete caused by corrosion of reinforcement?

Chain drag

Half-cell potential measurements

Chloride content measurement

9. How do you remove concrete prior to patching?

Mark perimeter Saw

cut perimeter

Pneumatic hammers

10. Patching can be done with what materials?

Ready mixed concrete

Prepackaged patching materials

11. True or False. Patching should include adequate clearance under the reinforcement, saturated surface dry surface, and the use of an internal vibrator.

True

12. When should white, pigmented liquid membrane curing material be applied?

Just before the surface dries

13. How much does typical bridge deck concrete shrink in one to two years?

Approximately 1 inch per 100 feet of length

14. Concrete gains strength the fastest at what temperature?

90°F

15. What information is needed to use the evaporation rate nomograph?

Air temperature
Relative humidity
Concrete temperature
Wind speed

16. What materials do we use to fill cracks?

High molecular weight methacrylate
Epoxy
Urethane

17. Hydraulic cement concrete overlays should be placed on what type surface?

Shot blasted and saturated surface dry

18. What type hydraulic cement concrete overlays are used in Virginia?

Latex-modified
Silica fume

19. Epoxy overlays should be placed on what type surface?

Shot blasted and dry

20. Epoxy test patches are constructed and tested to verify what is acceptable?

Materials
Surface preparation
Batching, mixing and placing materials

CHAPTER 3 – Concrete FIELD

1. What are the duties of a Hydraulic Cement Concrete Field Inspector?

To insure that construction operations produce the results called for by the plans and specifications

2. What daily records must the Hydraulic Cement Concrete Field Inspector keep?

Date, location of the work, weather conditions, test results, equipment in use, equipment idle, source of materials, and production records

3. What is a Certified Concrete Field Technician responsible for at the project site?

Quality control of concrete work

4. What is the purpose of inspection?

To keep the Engineer informed as to the progress and the manner in which the work is progressing.

5. What are the qualifications of an inspector?

Knowledge, common sense, observational skills and courtesy.

6. What is a good relationship of an Inspector with the Contractor?

The inspector should be friendly, but firm and impartial in making decisions.

7. Should an inspector know what testing is required at both the concrete plant and on the road?

Yes

8. What safety equipment should be used during road construction?

Hard hats, steel toed shoes, gloves, safety vests, protective clothing, safety glasses or anything else necessary to assure worker safety.

9. Between the following pairs of documents, which one has priority?

Special Provision Copied Notes or Plans Special Provision Copied Notes

Plans or Special Provisions Special Provisions

Specifications or Plans Plans

CHAPTER 4 - Concrete

1. When transporting concrete to the job site, how much water can be withheld and added after concrete arrives on the site?

One gallon per cubic yard

2. True. All forms must be mortar tight, sufficiently rigid, and oiled or wetted down before concrete placing.
3. The conditions which are most conducive to causing plastic shrinkage cracks are high winds and low humidity.
4. Exploration of the sub-foundation to determine its adequacy is done by the Contractor.
5. All forms must be treated with approved coating material or water .
6. It is permissible to use reinforcing steel bars with mill scale on them.
7. Proper use of vibrator involves vibrating vertically at regular intervals.
8. Before placing concrete on a surface, the surface should be oiled or wetted.
9. During cold weather concreting, the surface on which the concrete is to be placed should not be less than 40 °F.
10. The Contractor is responsible for removing and replacing concrete injured by frost action or freezing.
11. On a given day, if the air temperature was 60 °F; relative humidity 40%; surface temperature of the plastic concrete 75 °F and the wind velocity is 15 m/h, the Surface Evaporation Rate for Plastic Concrete on concrete bridge deck would be 0.25 lb/ft²/h.
12. The requirements for heating water, aggregates and cement in cold weather are water and aggregates 150°F max; cement shall not be heated.

13. In hot weather, all efforts should be made to place the concrete at or below their temperature.
14. Reinforcing steel bars, except those to be placed in vertical mats, shall be tied at every intersection where the spacing is more than 12 inches in any direction as found in Section 406.03(d).
15. When control cylinders are being used to determine removal of formwork from a deck slab, the minimum compressive strength of the deck slab is 60% f'_c as found in Section 404.03(j).
16. The requirements for the protection of reinforcing steel bars are found in Section 406.03(b).
17. Once concrete has begun to set in the finished surface, it shall not be disturbed or walked upon for a minimum of 24 hours as stated in Section 404.03(l)2.
18. Concrete may be permitted to freely drop a maximum of 1.5m(5ft.) as stated in Section 404.03(c).
19. Forms can be removed from a stem footer when the minimum compressive strength of the footer is 30% f'_c as found in Section 404.03.
20. In splicing a reinforcing bar, the minimum allowable length of lap is 30 times the bar diameter as found in Section 406.03(e).

Appendix D | page 37

Calculations for Concrete Plant Study Problem

1. Cement Weight Calculation (Line A 38-41)
635 lbs. (from TL-27) x 8 cubic yards = 5,080 lbs. of cement for 8 cubic yards
2. Sand, SSD Weight Calculation (Line A 46-50)
946 lbs. (from TL-27) x 8 cubic yards. = 7,568 lbs. of sand for 8 cubic yards
3. Sand, Free Water Calculation (Line A 51-53)
7,568 lbs. of sand for 8 cubic yards x .06 (% Free Moisture of Sand Expressed as a decimal) = 454.1 lbs. of free water = 454 lbs. (rounded to nearest whole lb.)
4. Coarse Aggregate (No. 57), SSD Weight Calculation (Line A 60-64)
1,922 lbs. (From TL-27) x 8 cubic yards = 15,376 lbs. of Coarse Aggregate for 8 cubic yards
5. Coarse Aggregate (No. 57), Free Water Calculation (Line A 65-67)
15,376 lbs. of C.A. (No. 57) for 8 yd³ X .002 (% Free Moist. of C.A. expressed as a decimal) = 30.8 lbs. of free water = 31 lbs. (Rounded to nearest whole lb.)
6. Total Allowable Water (Line B 13-16)
32.5 gals. (From TL-27) x 8 cubic yards = 260.0 gals. for 8 cubic yards

NOTE: All water on Line A is in pounds, but all water on Line B is in gallons.

7. Water Added at Plant (Line B 20-23)
454 lbs. of free water in sand (Line A 51-53)
+ 31 lbs. of free water in coarse aggregate (No. 57) (Line A 65-67)
485 lbs. of free water in sand and coarse aggregate

The pounds of free water in the sand and coarse aggregate from Line A must be converted to gallons. One gallon of water weighs 8.33 lbs.

485

8.33 = 58.2 gals. of free water in sand and coarse aggregate (rounded to nearest tenth)

1 gallon of water per cubic yard is being withheld at the concrete plant on each 8 yd³ load.

1 gal. per cubic yard x 8 cubic yards = 8.0 gals. of water withheld on each 8 yd³ load

The 58.2 gals. of free water in the sand and coarse aggregate goes into the mix with this material and becomes part of the mixing water and therefore must be subtracted from the total allowable water. Also, the 8 gals. of water withheld at the plant must be subtracted from the total allowable water.

58.2 gals. of free water in the sand and coarse aggregate
+ 8.0 gals. of water withheld per load at the concrete plant
66.2 gals. of water to be subtracted from the total allowable water

260.0 gals. of total allowable water (Line B 13-16)
- 66.2 gals. of free water in sand and C.A. plus 8 gals. per load withheld at plant
193.8 gals. of water added at plant (Line B 20-23)

8. A. E. Admixture (Line B 31-34)

5.0 oz. (From TL-27) x 8.0 cubic yards = 40.0 oz. for 8 cubic yards

9. Retarding Admixture (Line B 38-41)

25.0 oz. (From TL-27) x 8 cubic yards = 200.0 oz. for 8 cubic yards

[illegible]

Concrete Field Study Problem Solution

Form TL-13

FORM TL-13

REV. 2/96

VIRGINIA DEPARTMENT OF TRANSPORTATION MATERIALS DIVISION

NOTICE OF SHIPMENT OF CONCRETE CYLINDER

PROJECT NUMBER																	PLANT LOAD						DATE TAKEN						FIRST CYLINDER				SECOND CYLINDER				THIRD CYLINDER			
ROUTE				CO.			SECT.			TYPE			NO.						YY	MM		DD	SAMPLE				SAMPLE				SAMPLE									
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	48	49	50	51	56	57	58	59	64	65	66	67		
U	0	0	0	1	0	6	1	0	1	C	5	0	1		4	1	1	9	0	1	0	7	0	6	2	3	6				6 A				6 B					

CLASS OF CONCRETE A 3

GENERAL

SUBMITTED PROJECT INSPECTORS NAME